



INFLUENCE OF FORMALDEHYDE FROM INDOOR DECORATION ON BUCCAL CELLS OF THE RESIDENTS IN WUHAN

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ABSTRACT

In this study, 60 families in the same community were investigated. Among these families, 30 were decorated within one year while the corresponding ones decorated at least 4 years ago. Buccal cells donated by people available in these families were employed to carry out single cell gel electrophoresis (SCGE, Comet assay, for genotoxicity testing). Analysis of the comet images showed that the presenting rate of “comet” as well as the tail moments of the buccal cells’ DNA from people living in apartments decorated within a year were obviously higher ($P < 0.01$) than in those from people who lived in the apartments decorated several years ago, which lends strong support to our conclusion that people living in newly-decorated apartments are much more liable to be harmed by the formaldehyde released from their indoor decoration. In addition, high-quality decoration material tends to be less harmful to people.

INDEX TERMS

Formaldehyde, Genotoxicity, Comet assay, Buccal cell, Epidemiological study

INTRODUCTION

As Chinese economy booming in recent years, more and more people tend to choose complex decoration before they move into a new apartment. Such decorations, however, not always provide them with comfortable feelings as they expected. On the contrary, decorations with low-quality indoor decorating materials might even bring them trouble. Among several kinds of indoor pollutants brought by indoor decoration, formaldehyde is very dangerous because it can be released from plywood used in furniture making and floor covering as well as adhesives and coating agents used in wall decoration. Among many health effects brought by formaldehyde, DNA damage is an effective index of the genotoxicity. In order to explore the genotoxicity under the effect of formaldehyde sent out by some indoor decorating materials, we carried out a survey in Wuhan city from Aug. 22 to Sep. 13, 2004. Results of the study are as follows.

RESEARCH METHODS

Objectives

In this study, 60 families in a same community in Wuhan are investigated. Among these families, 30 were decorated within one year while the corresponding ones decorated at least 4 years ago. Besides, standards set up to select family members are as follows: (1) they must be non-smoking; (2) their working places have not been decorated within at least 1 year; (3) they do not have any health problems, such as rhinopharyngocele, that might also bring genotoxic effect to their buccal cells.

Materials

Buccal cells employed to carry out SCGE were obtained from people who meet the standards mentioned above in these families, by scrapping lightly the internal part of each cheek for 20 times with a clean soft toothbrush. Collected cells were added into 10ml of 0.9% NaCl solution and centrifuged at 2,500 rpm for 15 min, and then cells were resuspended in 2ml of 0.9% NaCl to make the cell suspension.

Methods

General data obtaining: Family members filled in questionnaires about the decorating situations of the families, including floor space, structure of the apartment, decorating material, decorating form, date of finishing decoration, date of moving in, and so on.

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Detection of the genotoxicity: Single cell gel electrophoresis (SCGE, Comet assay), a universal fluorescent microscopic technique to examine DNA damage and repair at individual cell level, are employed. The characteristic ‘comet’ image presents when DNA in nucleus is damaged, which cause loosening of the supercoil structure. The ‘comet tail’ is formed when fragments of broken DNA migrate to the anode direction during the electrophoresis. The index ‘Tail DNA%’ indicates the percentage of the total DNA in a cell that shapes the ‘comet tail’. Generally, the more serious the DNA is damaged, the higher the Tail DNA% is. In some cases, however, ‘tail length’ should also be taken into account. Therefore, ‘Tail Moment’, another index stands for the product of ‘Tail DNA%’ and ‘tail length’, is also necessary to be noticed along with ‘Tail DNA%’ in order to evaluate the DNA damage quantificationally and exactly. Both values of the above two important indexes can be obtained automatically under the image analysis of the CASP software.

Statistic Method

SigmaPlot 9.0 software is employed as statistic tool in this study.

RESULTS

Self-Conscious Symptoms

Investigations with questionnaires showed that among 45 residents living in 30 recently decorated apartments, 7 told that they had irritation feelings in their eyes, nose or throat (15.6%) while only 1 among 42 residents living in 30 apartments decorated at least 4 years ago share the same feeling (2.3%). The difference between the two groups was significant ($P < 0.01$).

Scge Results

Both Tail DNA% (with an average of 81.63) and Tail Moment (with an average of 24.39) result from the SCGE assay of the buccal cells donated by the residents living in apartments decorated within 1 year are much higher than those (with an average of 10.84 and 5.42, separately) donated by the residents living in apartments decorated at least 4 years ago. Result from the t-test shows very prominent distinction between data of the 2 groups ($P < 0.01$).

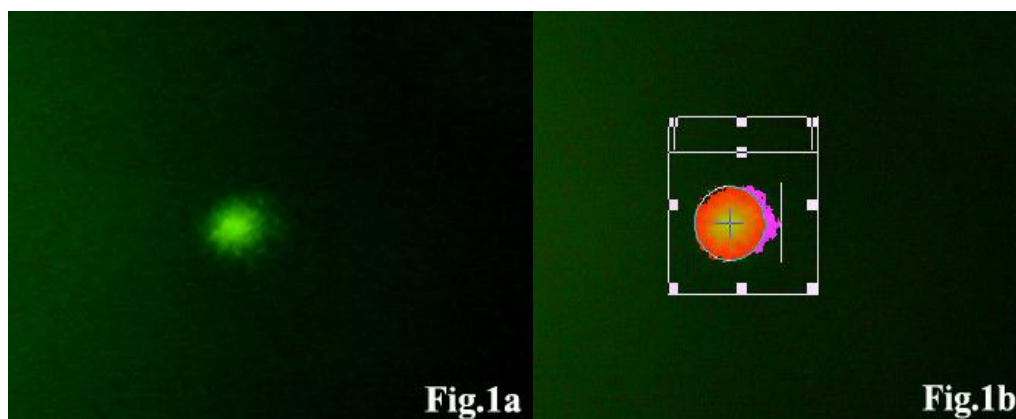


Figure 1. The comet figure of the buccal cell donated by resident living in apartments decorated at least 4 years ago from SCGE (a) and the analysis with CASP on the figure (b)

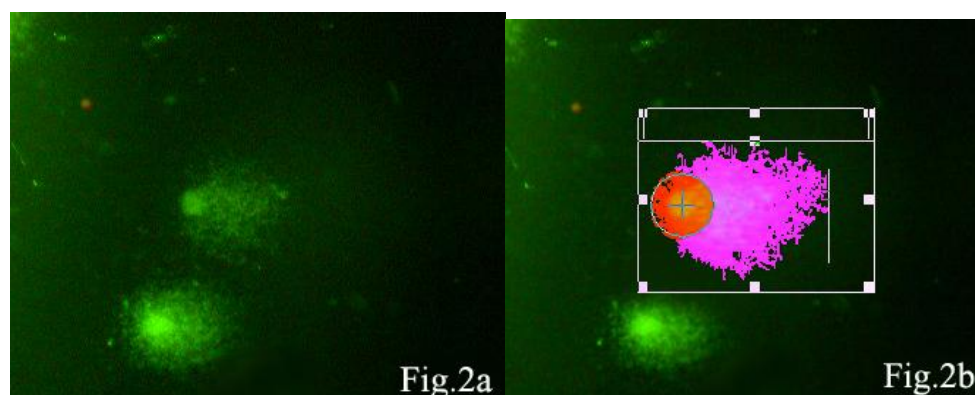


Figure. 2 Comet figures of buccal cells donated by resident living in apartments decorated within a year from SCGE (a) and the analysis with CASP on the figure (b)



As it is showed above, images of buccal cell that were donated by residents living in apartments decorated within a year (Fig. 2a) have much longer “comet tails” than that of the cell donated by resident living in apartments decorated at least 4 years ago (Fig. 1a). Analyzed results from CASP software also demonstrate the distinction (Fig. 1b, Fig. 2b) clearly by dividing the “comet head” and “comet tail” into different color-labeled areas. Both Tail DNA% (with an average of 81.63) and Tail Moment (with an average of 24.39) result from the SCGE assay of the buccal cells donated by the residents living in apartments decorated within 1 year are much higher than those (with an average of 10.84 and 5.42, separately) donated by the residents living in apartments decorated at least 4 years ago. As the SigmaPlot, the software we employed as statistic tool, analyzed, result from the t-test showed very prominent distinction between both Tail DNA% and Tail Moment of the 2 groups ($P < 0.01$).

DISCUSSION

Since it harms people’s health, indoor air pollution has attracted attention of scholars who always keep an eye on environment. Among many pollutants, the negative effect of formaldehyde has been observed in newly decorated apartments in many Chinese cities. Shizhen Liu et al. measured the formaldehyde contents of indoor air in fifty newly decorated houses in Wuhan according to the national standard method and found that the contents in forty houses exceed 0.08 mg/m^3 , the indoor formaldehyde concentration standard stipulated in the indoor air pollution standard: GB18883-2002 published by Ministry of Health of P. R. China. Besides, Jianhui Tang et al., Jingshun Li et al. and Xiaoning Guo et al., investigated newly decorated apartments in Guangzhou, Changchun and Yinchuan, respectively. Not surprisingly, they reached almost the same conclusion as Liu did.

As a main chemical pollutant produced in indoor decoration, formaldehyde is widely studied not only because it comes from many sources with relative high concentration, but also because it is highly nocuous and can last for a comparatively long period. Formaldehyde can cause watery eyes, burning sensations in the eyes and throat, nausea, and difficulty in breathing in some humans exposed at elevated levels. High concentrations may trigger attacks in people with asthma. Besides, high concentration formaldehyde is even a kind of suspected human carcinogen (WHO 2002). DNA damage of human buccal cells, as a direct evidence for the genotoxicity caused by formaldehyde, is employed to detect the effect of indoor decorations. Relative research has been carried out in our team for several years (Rui Li et al 2004, Zhisong Lu et al 2003, Zhisong Lu et al 2004) and $50 \text{ }\mu\text{M}$ or higher concentrations of formaldehyde have been ascertained to be genotoxic to buccal cells.

SCGE was first developed by Swedish researchers Östling and Johansson (1984) and was later modified by N.P. Singh et al. (1988) as Alkaline Comet Assay. The assay is attractive because of its simplicity, sensitivity, versatility, speed, and economy. Over the past decades, the comet assay has become one of the standard methods for assessing DNA damage, with applications in genotoxicity test, human bio-monitoring and molecular epidemiology, ecogenotoxicology, as well as fundamental research in DNA damage and repair.

In this study, analysis of the comet images showed that the tail moments of the buccal cells’ DNA from people living in apartments decorated within a year are obviously higher ($P < 0.01$) than in those from people who live in apartments decorated four years ago, which lends strong support to our conclusion that people living in newly-decorated apartments are much more liable to be harmed by the formaldehyde released from their indoor decoration. In addition, high-quality decoration material tends to be less harmful to people.

To respond to this result, we suggest that people planning to move house should not be anxious to live in a newly-decorated apartment until at least the formaldehyde concentration of the indoor air is detected to be below 0.08 mg/m^3 , as the national standard prescribes. Besides, high-quality materials should be employed rather than the bad ones in indoor decoration and ventilation is a habit beneficial to the health.

CONCLUSION

Single cell gel electrophoresis (SCGE, Comet assay) is a very good laboratory test for genotoxicity of animals; our study results demonstrate it is also a good test for human genotoxicity if we take samples from people’s buccal cells.

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**REFERENCES**

- Guo XN., Yu FS., Ding HY., et al, 2003. Analysis on Formaldehyde Pollution and Protective Measures to Newly Decorated Rooms in Yinchuan. *Journal of Ningxia Medical College*, 25(6): 415-416
- Li JS., Zhao SH., Yi X., et al, 2002. Investigation on the Housing Decoration Pollution from Formaldehyde. *Chinese Journal of Public Health Engineering*, 11(13): 136-137
- Li R., Lu ZS., Qiao Y., et al, 2004. Study on the formaldehyde-Induced DNA damage with comet assay. *Acta Biologiae Experimentalis Sinica*, 37(4): 262-268.
- Liu SZ., Cao ML. and Hou QZ., 2005. Analysis and study on formaldehyde content of indoor air in newly decorated house in WuHan. *North Environment*, 30(1): 25-27
- Lu ZS., Qiao Y., Yan Y., et al, 2004. Study on the method of human buccal cell comet assay. *Research of Environmental Science*, 17(3): 66-70.
- Lu ZS., Yan Y., Qiao Y., et al, 2003. Study on genotoxicity of gaseous formaldehyde on human buccal cells. *China Environmental Science*, 23(6): 566-569
- Östling O. and Johanson KJ. 1984. Microelectrophoretic study of radiation-induced DNA damages in individual mammalian cells. *Biochem. Biophys. Res. Commun.*, 123: 291-298
- Singh NP., McCoy MT., Tice RR. and Schneider EL. 1988. A simple technique for quantitation of low levels of DNA damage in individual cells, *Exp. Cell Res.* 175: 184-191
- Tang JH., Wang XM. and Sheng GY., et al, 2003. Analysis of Formaldehyde Content of Indoor Air in Newly Constructed and Decorated House in Guangzhou. *Journal of Instrumental Analysis*, 22(1): 71-73
- World Health Organization, 2002. Concise International Chemical Assessment Document 40: Formaldehyde.